A Review of the Evaluation and Treatment of Heel Pain, Part 1

A panel of specialists walks you through the assessment of heel pain. Part 2 will review various diagnoses for heel pain.

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Heel pain is a common condition bringing patients into the doctor’s office. It is said about 10 percent of the population will be affected by heel pain in their lifetime.1 If left untreated, it may cause severe and debilitating discomfort that can ultimately lead to dysfunction. A variety of soft tissue, osseous, and systemic disorders can precipitate into heel pain. More specifically, examples of common causes include plantar fasciitis, heel spur, tarsal tunnel syndrome, stress fractures, as well Achilles tendonitis.2

In order to provide a cost effective workup and appropriate diagnosis, an accurate history and physical examination of the lower extremity is essential. Imaging studies are also helpful when an infection, stress fracture, or trauma is suspected. Various treatment options are available depending on the source of pain; therefore an accurate diagnosis is important. Conservative management may include oral medications, physical therapy and durable medical equipment. Depending on the severity of the pain, injections and surgical intervention may also be an option.2 This article provides a thorough review of diagnoses and treatment options available for various heel pains.

EPIDEMIOLOGY

Heel pain is said to be highly prevalent in the general population. A study showed that up to one million patient visits to physicians a year were for diagnosis and evaluation of heel pain in the US.3 It is the most common complaint seen by foot and ankle specialists estimated at 11-15 percent of adults.4 The average age is adults 40–60 years old. The most common cause in children and adolescents is calcaneal apophysitis (Sever’s disease).5 Current studies have shown inconsistent results associating heel pain and gender. The disorder is observed in people with sedentary lifestyles, involved with routine/manual labor, and elevated BMI. It accounts for a quarter of all foot injuries seen in runners. The cause of heel pain is thought to be multifactorial, intrinsic and extrinsic risk factors. These included limited dorsiflexion, leg length discrepancy, reduced heel pad thickness, excessive foot pronation, reduced calf strength, prolonged standing and inappropriate foot wear.6

FOOT AND ANKLE ANATOMY

The calcaneus is the largest bone in the foot. Its cortical bone is often compared to that of an eggshell, being that the bone is mostly cancellous and therefore not as rigid as the other bones of the foot. When looking at the calcaneus, one can picture it as a three dimensional rectangle with unique shape/attachments/joints on all of its six surfaces. It can thus be divided into a superior, inferior, medial, lateral, anterior, and posterior aspect. We will first discuss the bony architecture of the calcaneus followed by the surrounding soft tissue and neurovascular anatomy.7

The superior surface is composed of three facets that collectively form the calcaneal aspect of the subtalar joint. The posterior, middle, and anterior calcaneal facets articulate
with their corresponding talar facets. Posterior to the posterior facet of the calcaneus lies the non-articulating surface. Between the posterior and medial facets is where the sinus tarsi is formed with a combination of the sulcus calcanei and sulcus tali often containing the interosseous ligament which then becomes the cervical ligament laterally. The medial facet lies directly over the sustentaculum tali and is often joined to the anterior facet. In a study by Bunning and Barnett examining 492 calcanei, they classify the calcaneus into types A-C.8 Type A is one in which the middle and anterior facets are separate, type B in which they are joined, and Type C in which all three facets are united. The prevalence of Type A was 36 percent, type B 63 percent, and Type C 1 percent. The Extensor Digitorum Brevis muscle belly arises from the dorsolateral aspect of the calcaneus [Figure 1.1].7

The inferior surface is the postero-inferior aspect of the calcaneus has two tuberosities; a larger medial and smaller lateral tuberosity. The medial tuberosity is the main aspect of the calcaneus through which weight bearing takes place. The medial and lateral tuberosities are the points at which the intrinsic muscles in the first layer of the foot originate. It is also the point at which the plantar fascia attaches. The term “heel spur,” which is often used synonymously with plantar fasciitis, is the bony protrusion of the medial tubercle secondary to tension forces of the plantar fascia. The anterior tubercle gives rise to the ligaments connecting the calcaneus to the navicular and cuboid [Figure 1.2].7

The medial surface is the sustentaculum tali is a shelf like projection on the medial aspect of the calcaneus that allows the Flexor Hallucis Longus tendon to traverse under it on its way to the hallux. The sustentaculum tali is also the site at which one of the deltoid ligaments of the medial ankle attaches.7

The lateral surface in the middle of the calcaneus one can find the peroneal tubercle. This bony protuberance is the site of attachment for the inferior peroneal retinacula, which separates the peroneus brevis (superiorly) and longus (inferiorly). In an article by Edwards et al., the tubercle was found in 98 percent of 150 calcanei (first reference). The inferior aspect of the calcaneus is directly subcutaneous.7,8

The posterior aspect of the calcaneus is divided into thirds. The superior one-third is non-articulating and is angled anteriorly. In many patients, this is the site for a Haglund’s deformity or “pump bump.” Directly anterior to the Achilles tendon at this site, one will find the retrocalcaneal bursa. The middle third has a ridge for the attachment of the Achilles and Plantaris tendons. The inferior one-third is contiguous with the plantar aspect of the calcaneus [Figure 1.3].9

The anterior surface is a saddle shaped articular surface for the calcaneo-cuboid joint.9
EXPERT OPINION

The soft tissue anatomy of the heel is mostly comprised of fat superficially, which serves as a cushion for walking. The plantar fat pad is unique in that it is comprised of soft tissue septae of elastin, which gives it more elasticity to absorb shock. Deep to the plantar fat pad is the plantar fascia covering the first layer of intrinsic muscles. The plantar fascia is a thick connective tissue originating from the medial and lateral tubercles of the calcaneus. The plantar fascia is composed of a medial, central (plantar aponeurosis) and lateral layers. It inserts distally into the soft tissue of the forefoot by the MPJ and proximal phalanges. During the gait cycle, when the digits are dorsiflexed, the plantar fascia becomes taught in what is known as the windlass mechanism. There are three things which maintain the arch in a foot, with the plantar fascia being the second most important after the architecture of the bones. Anything that causes traction on the plantar fascia may cause heel pain.

In an article by Harvey Lamont, the composition of fascia was examined to see if there was truly an inflammatory component to heel pain. What he found was that there was myxoid degeneration in patients with heel pain as opposed to inflammation. He therefore coined the term plantar fasciosis as opposed to fasciitis indicating that the etiology is degenerative as opposed to inflammatory. Beneath the plantar fascia lies the first layer of muscles originate at the medial and lateral tubercles of the calcaneus. The Abductor Hallucis and the medial margin of the quadrates plantae. The third and fourth muscle layers originate at the lateral tubercles of the calcaneus.9 The plantar fascia is comprised of the quadratus plantae and lumbrricals. The third and fourth muscle layers originate from the lateral tubercle. The second layer of muscle is composed of the quadratus plantae and plantarflexion. The third and fourth muscle layers originate from the midfoot region. The muscles are the last and least influential in maintain arch height.

The blood supply to the heel is comprised of branches from the posterior tibial artery medially and the peroneal artery laterally. Adjacent to the arteries you will find the venae comitantes which run parallel on either side of the artery. Both arteries will give off the medial and lateral calcaneal nerves respectively. The neural distribution is comprised of the tibial nerve posteromedial, which divides into the medial and lateral plantar nerves. The tibial nerve also gives off the plantar fascia being the second most important after the architecture of the bones. Anything that causes traction on the plantar fascia may cause heel pain.

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BIOMECHANICAL CONSIDERATIONS

An understanding of normal foot biomechanics offers insight into the pathogenesis of various clinical entities manifesting as heel pain. The subtalar joint, midtarsal joint, and plantar fascia are the hind foot structures governing normal foot function.

The three articulations between the talus and calcaneus comprise the functional subtalar joint. Motion about the subtalar joint takes the foot from a position of inversion, adduction, and plantarflexion to one of eversion, abduction, and dorsiflexion. This occurs about an axis deviated approximately 42 degrees from the transverse plane and approximately 16 degrees from the sagittal plane. During stance, movement of the talus on the calcaneus has been compared to a screw. With eversion of the calcaneus, there is adduction, plantarflexion, and anterior displacement of the talus.

The subtalar joint is made up of the talonavicular and calcaneocuboid articulations. Classically, the midtarsal joint has been described as a biaxial joint whose axes are brought into parallel as the subtalar joint pronates. With the axes in parallel, the midtarsal joint is flexible permitting a small degree of supination and pronation. Conversely, with supination of the subtalar joint, the midtarsal joint axes diverge, and little motion is available; thus, the midtarsal joint is locked. More recent work has called this model into question, describing Elftman’s theory as more of a convenient hypothesis. A more robust model of midtarsal joint locking is a subject of ongoing research.

The plantar fascia originates on the plantar medial aspect of the calcaneus and courses anteriorly inserting into the plantar plate of each digit. With extension of the digits, particularly the great toe, the plantar fascia is pulled taut, effecting subtalar supination. Through this mechanism, compared to a windlass, the arch of the foot is propped up and stabilized.
During the normal human gait cycle, the lower extremity goes through alternating stance and swing phases. The stance phase is further subdivided into intervals characterized by heel strike, midstance, and toe off. To transition through these intervals, the foot must be able to function as both a shock absorber and as a rigid lever.15

At heel strike, the subtalar joint is partially supinated and ground reactive forces move the subtalar joint into a position of pronation, unlocking the midtarsal joint. In this configuration, the foot can absorb the shock of weight bearing while moving into midstance. During midstance, the subtalar joint then resupinate, locking the midtarsal joint so the foot may function as a rigid lever. With plantarflexion of the ankle and heel off, the toes are forced into extension, triggering the windlass mechanism whereby the arch of the foot is further stabilized. Any insufficiency in these mechanisms has the potential to result in chronic injury to the foot in general and heel pain in particular.15

HISTORY AND SYMPTOMS

A thorough history in the patient with heel pain is essential for determining a diagnosis and treatment plan. Most importantly, detailed questioning of the patient should be performed to precisely localize the pain to either a plantar, midfoot, or posterior location.16 Next, the quality of the pain should be clearly detailed. For instance, patients with plantar pain should be questioned about a significant burning and tingling component, which may suggest nerve entrapment or a neuroma. Additionally, the timing of pain episodes should be obtained. Commonly, patients with plantar fasciitis will describe their worst pain with their first weight bearing steps after sleep or other restful periods. However, if upon history patients describe pain that gets worse with prolonged weight bearing, then heel pad syndrome or a plantar wart should be considered as possible etiologies. Patients who report continuous pain at rest should be evaluated for a bony derangement such as calcaneal stress fracture.17

Patients who localize their heel pain to that of the midfoot should be further questioned as to a lateral or medial location of their midfoot pain. The medial location is commonly associated with tarsal tunnel syndrome. If, however, upon the history the patient reports a posterior location of heel pain, then the location of the pain with respect to the Achilles tendon becomes important. Pain located near the insertion of the Achilles tendon demands consideration of a possible Achilles tendinopathy and pain adjacent to the insertion of the tendon lends itself to evaluation for a Haglund deformity with or without a coexisting bursitis.16,17

As with other painful syndromes, the duration of symptoms should be established, and the trajectory of improvement or worsening should be established. Any peripheral or central radiation of pain symptom should be elucidated. The practitioner should inquire about any medical, interventional, or surgical past therapies, and the relative success or failure of each. Any other relevant comorbidities such as diabetes, vascular insufficiency, rheumatologic disease, depression, mobility, and dietary or nutritional deficiencies should also be discussed.16,17

PHYSICAL EXAMINATION

A thorough physical exam of the entire ankle, heel and midfoot is critical to establish a proper diagnosis. The thorough examiner may inspect the footwear first to look for a pattern of wear that might be consistent with over pronation or over supination.18

Inspection of the foot should uncover any discoloration, skin thickness, skin breakdown, pressure points, changes in vascularity, hair growth, and nail plate thickness. A sensory exam should uncover any areas of paresthesia or numbness that may be suggestive of neuropathy or radiculopathy.19 Next, both active and passive range of motion at the ankle should be checked and documented. If dorsiflexion of the ankle is limited then the physician may perform Silverskiold’s test. This test is performed with one hand placing pressure on the plantar surface of the ball of the foot pushing away from the examiner, and another hand pulling the posterior surface of the calcaneus toward the examiner, and assesses for gastrocnemius tightness or contracture.19,20

Tenderness over the calcaneus and increased pain with passive dorsiﬂexion of toes may be suggestive of plantar fasciitis, one of the most common causes of heel pain. Dorsiﬂexion of the toes with eversion of the foot (the dorsiﬂexion–eversion test) tightens the windlass mechanism of the foot arch and has classically been thought to exacerbate pain in Plantar fasciitis.

Certain authors have challenged the speciﬁcity of this test, but it is still commonly described in literature. Pain upon resisted flexion of the toe will exacerbate pain in the case of ﬂexor hallucis longus tendonitis.19

Many times pain increases with dorsiﬂexion when this pathology is present. In severe cases a rupture of the plantar fascia should be considered if a palpable defect is present at the calcaneal tuberosity accompanied by localized swelling and ecchymosis.18 If palpation of the soul or heel reveals a pinpoint and painful lump (the lamp cord sign), then a neuroma of the medial calcaneal nerve should be considered.19

If there is pain and tenderness upon palpation of the posterior calcaneus then a retro calcaneal or retro Achilles bursitis must be considered. The retro calcaneal bursa is located between the calcaneus and the Achilles tendon.
insertion, while the retro Achilles bursa is located between the Achilles tendon and the skin. Additionally, pressure should be applied to the tarsal tunnel. If the patient symptoms are reproduced with percussion over the tarsal tunnel then a tarsal tunnel syndrome should be suspected. The tarsal tunnel is located on the medial aspect of the posterior heel, and is bounded by the flexor retinaculum, the talus, and the calcaneus. In this pathology symptoms may also be reproduced by dorsiflexion and eversion of the foot. This is commonly referred to as the dorsiflexion eversion test. Pes planus causes increased abduction at the forefoot and can increase tension on the tibial nerve, thereby predisposing the patient to tarsal tunnel syndrome.

**TABLE 1**

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<thead>
<tr>
<th>Mechanical</th>
<th>Posterior heel pain:</th>
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<tr>
<td>Plantar heel pain:</td>
<td>Insertional Achilles Tendinopathy or</td>
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<tr>
<td>• Plantar Fasciitis</td>
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<td>• Heel Spur Syndrome</td>
<td>Haglund’s Deformity with or without</td>
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<td>• Plantar Fasciosis</td>
<td>Retrocalcaneal Bursitis</td>
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<td>• Tarsal Tunnel Syndrome (Posterior Tibial)</td>
<td>• S1 Radiculopathy</td>
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<td>• Heel Neuroma (Medial Calcaneal)</td>
<td>Double-Crush Syndrome</td>
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<td>• Medial Plantar</td>
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<td>• Sural, including Lateral Calcaneal Proximal</td>
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<td>Reiter’s Disease</td>
<td>Lateral Plantar</td>
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<td>Diffuse Idiopathic Skeletal Hyperostosis (DISH)</td>
<td>Sural, including Lateral Calcaneal</td>
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<td>Rheumatoid Arthritis</td>
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<td>Fibromyalgia</td>
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<td>Gout</td>
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<td>Stress fracture</td>
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<td>Soft tissue trauma (Acute Plantar Fascia Rupture)</td>
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<th>Other</th>
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<td>Infection (soft tissue or bone)</td>
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<td>Vascular</td>
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<td>Calcaneal apophysitis in adolescents</td>
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Pain and tenderness over the insertion of the Achilles tendon on the calcaneus may be suggestive of Achilles tendinopathy. If tenderness is located adjacent to the Achilles tendon on the medial side of the ankle then tendinopathy of the posterior tibialis, the flexor digitorum longus, and flex or analysis longus should be considered. Alternatively if tenderness is greatest on the lateral side adjacent to the Achilles tendon then a peroneal tendinopathy should be considered. If the calcaneus is found to be tender upon medial or a lateral compression, and the patient complains of diffuse heel pain, then a stress fracture of the calcaneus should be considered.

**DIFFERENTIAL DIAGNOSIS INHEEL PAIN**

Heel pain may be due to arthritic, neurologic, traumatic or other systemic conditions but most commonly is mechanical in origin (Table 1). The most common locations for mechanically-induced heel pain are the plantar and posterior heel. Plantar heel pain is the most prevalent complaint presenting to foot and ankle specialists, seen in up to 11-15 percent of adults and is due to plantar fasciitis, heel spur syndrome or plantar fasciosis. Most commonly it presents as worst in the morning during the first steps of weight bearing with temporary improvement in symptoms as the day progresses, which once again worsens at the end of the day. Posterior heel pain can be due to either Achilles insertion tendinopathy (or enthesopathy) or Haglund’s deformity (with or without retrocalcaneal bursitis). Achilles enthesopathy most typically presents insidiously and often leads to chronic posterior heel pain with swelling aggravated by increased activity and increased pressure caused by shoe’s heel counter. Haglund’s deformity most commonly affects people 20 to 30 years of age with pain worsened with shoe wear and relieved with barefoot walking or use of open-heel shoes.

Additional causes of heel pain include neurologic causes, arthritis and trauma. Neurologic heel pain is defined as pain in the heel due to entrapment or irritation of one or more of nerves. Causes could be related to obesity, venous insufficiency, trauma or a space-occupying lesion. More commonly affected nerves or nerve branches include the following: posterior tibial (tarsal tunnel syndrome), medial calcaneal (heel neuroma), medial plantar, lateral plantar including branch to abductor digiti minimi, and sural including lateral calcaneal.

Neurologic heel pain may also be attributed to more proximal nerve impingement syndromes such as an S1 radiculopathy. Double crush syndrome occurs when there are simultaneous proximal and distal nerve entrapments. Heel pain related to systemic arthritis could be related to seronegative arthritis, psoriatic arthritis, Reiter’s disease, diffuse idiopathic skeletal hyperostosis (DISH), rheumatoid arthritis, fibromyalgia and gout. Acute trauma to the calcaneus is the most common...
osseous cause of heel pain and is typically a result of a fall from a height onto the heel. Intra-articular fractures involving the subtalar joint result in diffuse pain in the hind foot that is poorly localized to the heel itself while less severe injuries will have more focal symptoms that correspond to the anatomic area of fracture, such as injury to the sustentaculum tali or the plantar calcaneal tubercles, avulsion of the posterior aspect of the tuber, or even fracture of the inferior calcaneal spur.

Stress fractures may also occur as a result of repetitive loading onto the heel with most common sites being immediately posterior and inferior to the posterior facet of the subtalar joint. With stress fractures, patients may report an increase in walking activity immediately before the onset of symptoms. Soft tissue trauma such as acute plantar fascia rupture may also be a cause of heel pain.

Other less common causes of heel pain include benign and malignant tumors, soft tissue or bone infections and vascular compromise. In adolescents, one of the most frequent causes of heel pain is calcaneal apophysitis.

DIAGNOSTIC IMAGING OF THE HEEL AND FOOT
Standard radiographs are the first step in evaluation of heel pain. The source of pain from bone spurs, arthritis and tumors can be imaged with anterior-posterior and sagittal x-rays of the foot. Heel spurs, stress fractures and space occupying lesions would be assessed with this modality. Figure 1.4 demonstrates the presence of large calcaneal heel spurs in his patient with heel pain. Once this x-ray was obtained the patient was advised on proper shoe wear and the pain was controlled. Calcification in the soft tissues can be a sign of gout or vascular insufficiency and appropriate steps can be taken to educate and treat the patient.

In cases where standard x-rays do not reveal the source of pain, more advanced imaging may be indicated. Sonographic evaluation of the plantar fascia and its insertion onto the calcaneus can easily show the characteristic pathologic changes associated with plantar fasciopathy. This is a non invasive technique which is relatively inexpensive. It is performed by a trained ultrasound technician and interpreted by a radiologist. There is no pain associated with the study and no radiation. Characteristic sonographic findings of plantar fasciopathy include a thickened hypoechoic cord of the plantar fascia, [Figure 1.5] with loss of the normal fibrillary pattern. Hypoechoic foci may be present within the thickened fascia, reflecting focal areas of collagen necrosis.

MRI scanning of the foot is the most sophisticated imaging modality and would yield the most information. It is the most expensive of the tests and is also non-invasive. Patients who have ferromagnetic implants such as pace makers or aneurysmal clips are contraindicated for this test. Visualization of the bony structures, cartilage and soft tis-
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sue is possible with the MRI.25 Partial and complete tears of the plantar fascia [Figure 1.6] or Achilles tendon are evident with this study. Signal changes in the soft tissue can be indicative of edema or infection. Cartilage loss and early arthritis can be seen in the ankle joint and subtalar joint. Soft tissue swelling and fluid collections are best appreciated with this study. It is the most complete of the studies and renders the most information.26

Part 2 of this series will appear in the July/August edition of Practical Neurology™.

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